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## Proposed Changes to the AIRS Gain & Circumvention Table

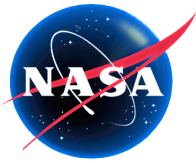
Steve Broberg

California Institute of Technology, Jet Propulsion Laboratory,  
4800 Oak Grove Dr. Pasadena

April 23, 2010

AIRS Science Team Meeting  
Pasadena, CA

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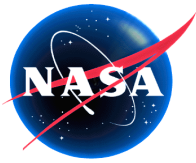
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## G&C Table Overview (1)



- AIRS has 2378 IR channels, of which the 2104 photovoltaic (PV) channels have two detectors which can be used singly, or in combination.
- The combination of the A & B detectors is weighted to optimize channel performance (A, B, or A+B). These weights are set in the “Gain & Circumvention (G&C)” Table.
- Radiation circumvention thresholds are also set on a per detector basis in the G&C table for each of the 2104 PV channels.



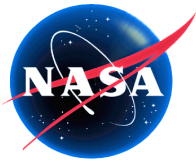
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## G&C Table Overview (2)



- AIRS has been in continuous operation since the 11/2003 restart until the 01/2010 power supply single event upset (SEU), which resulted in AIRS being placed in safe mode.
- The G&C table has not been updated since 11/18/03. The performance of some detectors has changed since then.
- Startup calibration procedures were run after the 1/2010 power supply SEU safing, including the nominal A/B optimum weighting algorithm.



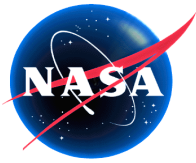
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## G&C Table A/B Optimization (1)



- The nominal A/B optimum weighting algorithm selects optimal weights based on detector noise characteristics (NEDT, non-gaussian, popping).
- The nominal algorithm identified 241 channels which could be improved by changing weights.
- The primary feedback (Strow) we've had regarding detector weights is paraphrased as "don't change them unless there is a compelling reason", for reasons of continuity, slight spectral changes, and grating modelling.



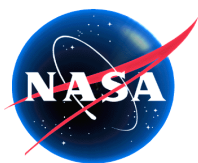
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## G&C Table A/B Optimization (2)



- The nominal algorithm channel A/B weights were reviewed in detail, and the list was culled to minimize changes in weight for marginal changes in performance.
- 163 channels were identified as candidates for changing A/B weights. Of these 163 ...
  - 40 had suffered radiation hits
  - 29 had highly irregular gains (non-responsive, “dead”).
  - 94 had significant differences in noise characteristics between A & B detectors (high noise, non-gaussian, pops, cold scene noise).



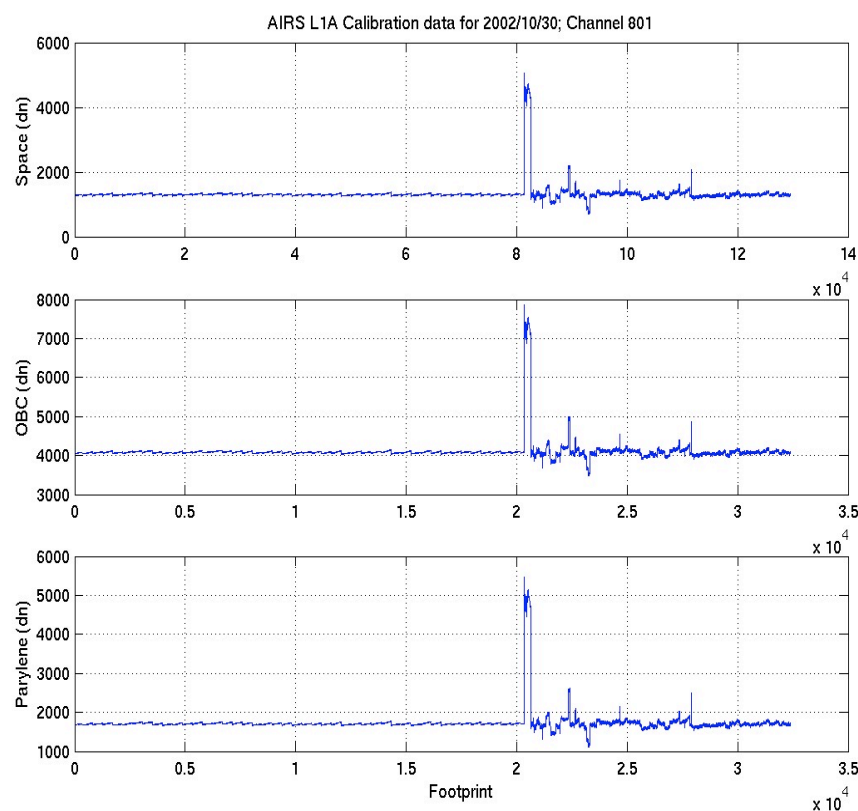
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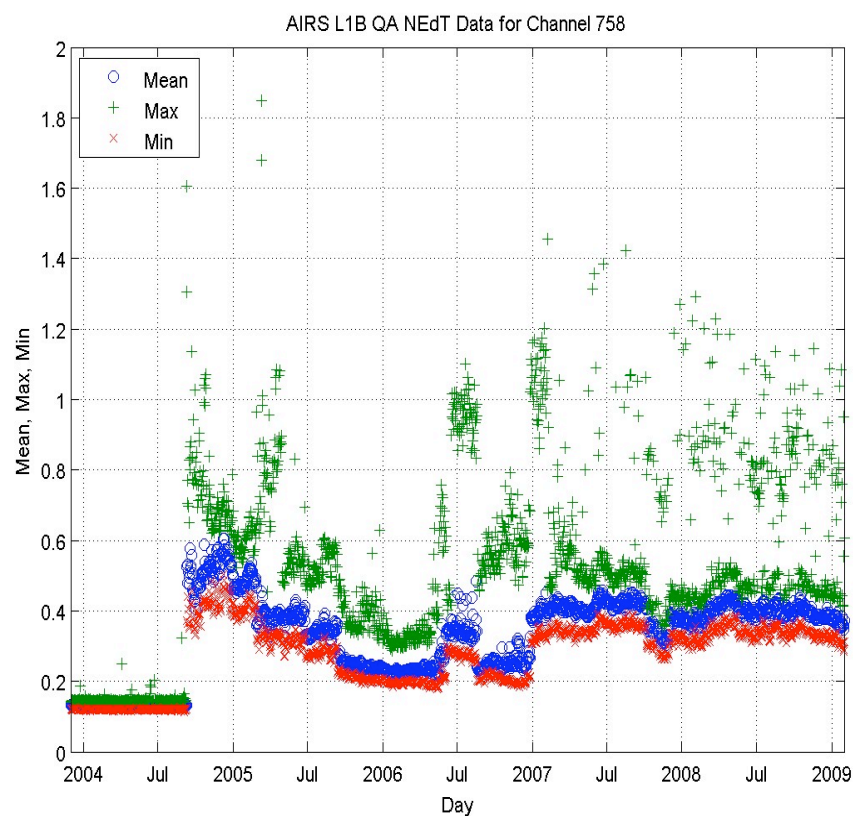
# Radiation Hit Examples

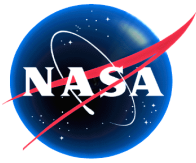


## DN Response in Calibration Views



## NEdT (daily mean, min, max)





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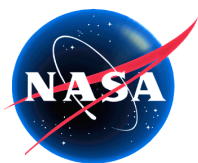
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## G&C Table A/B Optimization (3)



- 153 of the 163 are currently in L. Strow's "bad list" and 10 in the "good list". Here are the 10:
  - 437: A+B; A clean, B pops
  - 551: A+B; A pops, higher NEDT (0.6 vs. 0.4 K)
  - 592: A+B; A non-gaussian (430 N3sig vs. 107 typical)
  - 600: A+B; B rad hit; NEDT 0.7 vs. 3.1K
  - 647: A+B; B rad hit; NEDT 0.35 K -> 0.61 K
  - 699: A+B; B rad hit; NEDT 0.2 vs. 2.2 K
  - 715: A+B; B rad hit; NEDT 0.3 K vs. 6.5 K
  - 1142: A+B; A degraded, NEN varies; 0.38 K vs. 0.16 K
  - 1750: A+B; A rad hit; NEDT 0.12 -> 0.27 K
  - 2288: A+B; B rad hit; NEDT 0.5 -> 1.5 K





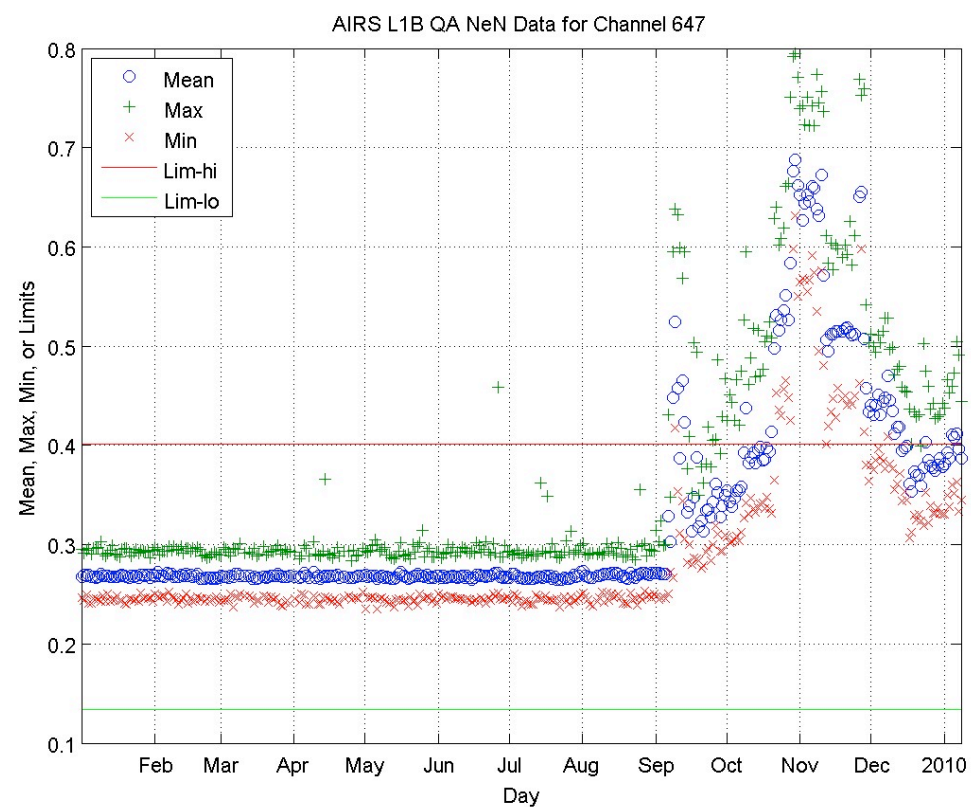
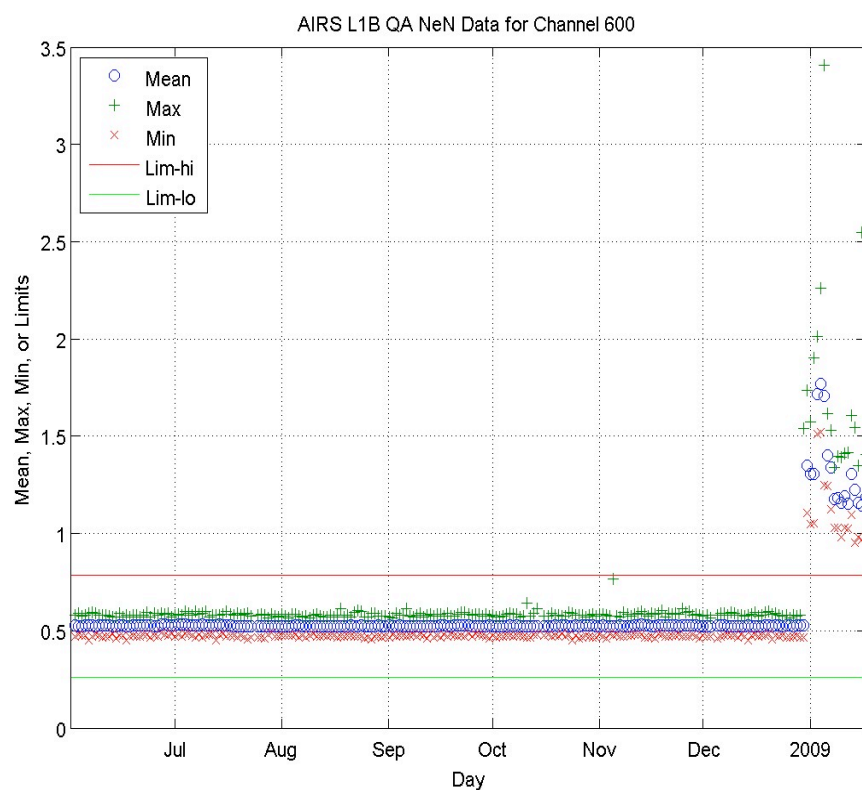
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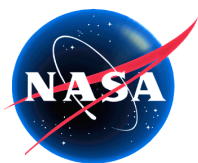
# Example Candidate Channels



## NEN changes (daily mean, min, max)







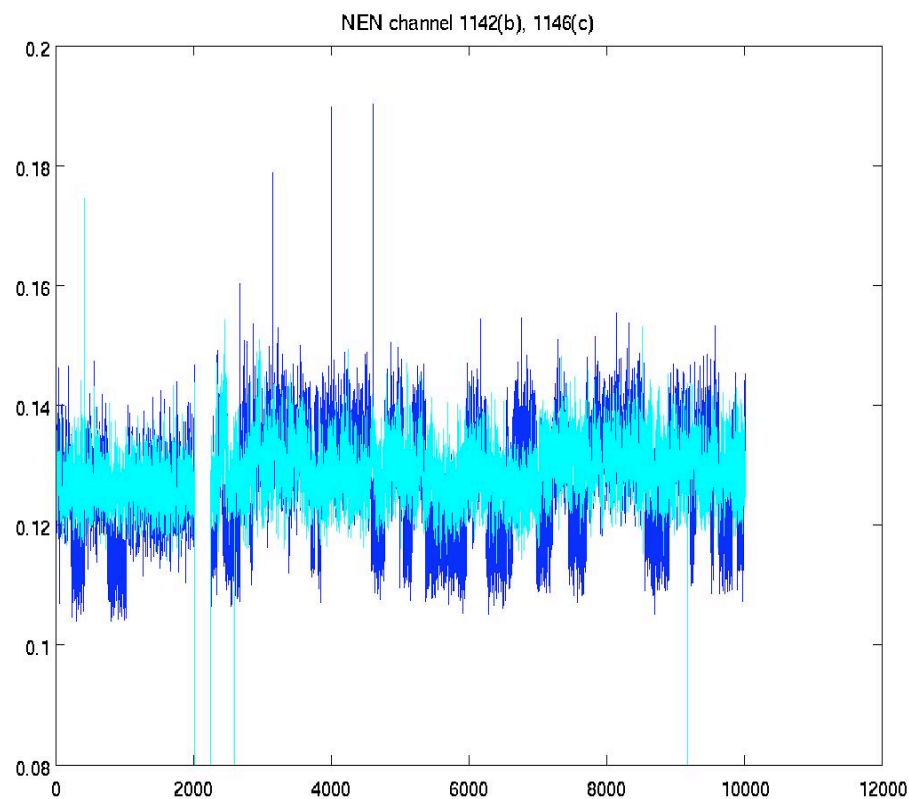
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# Example Candidate Channels

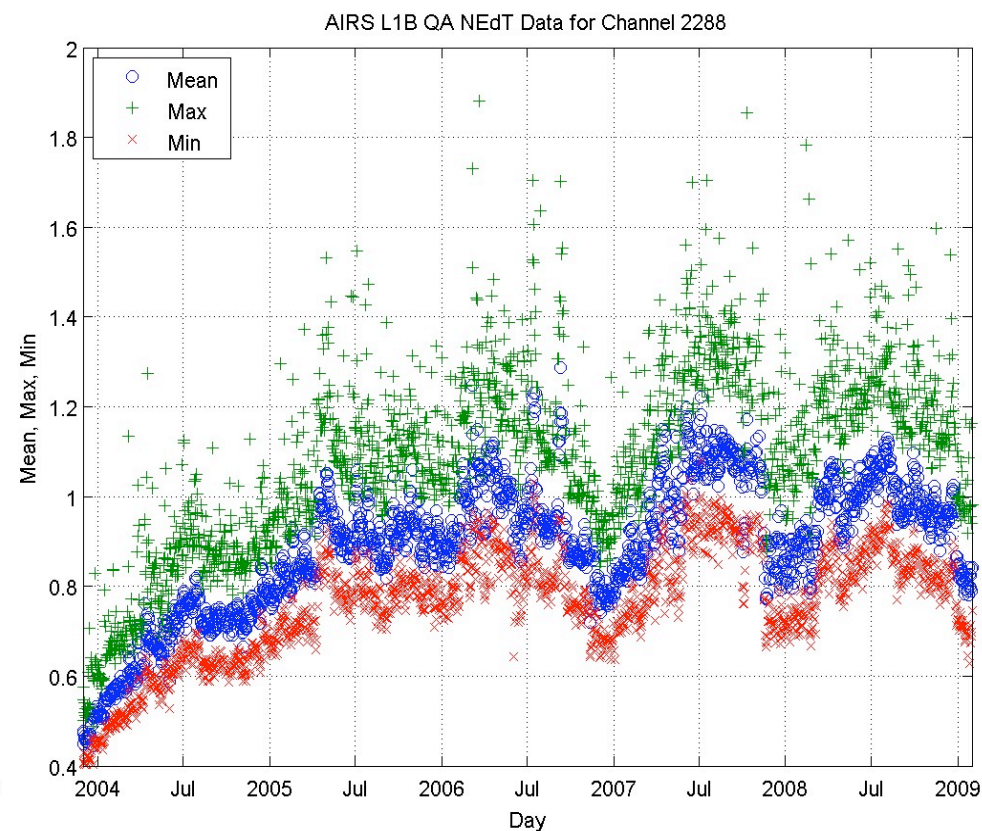


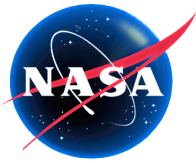
## NEN, per granule, Jan 2010



Jan 2010, per granule

## NEdT changes (daily mean, min, max)





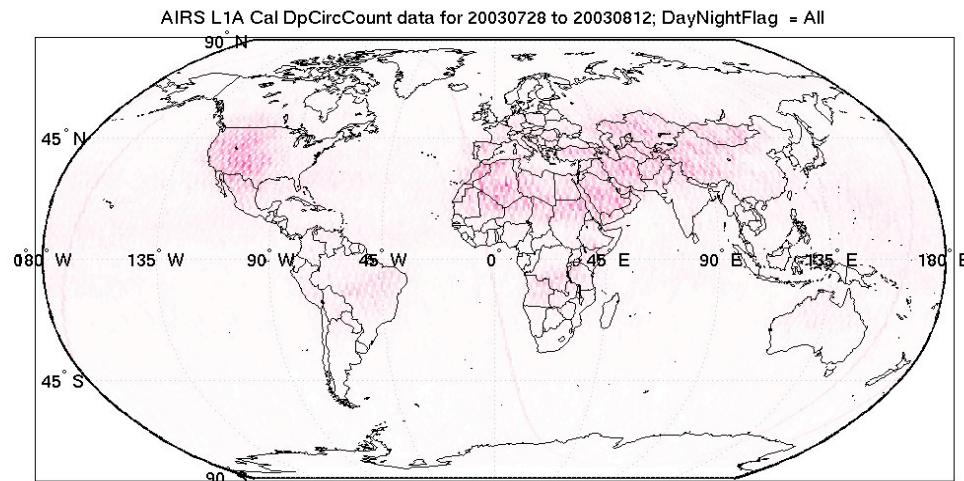
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## G&C Table - Circumvention

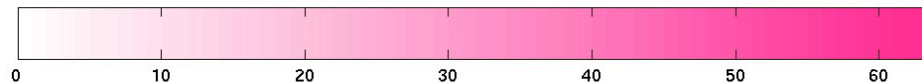


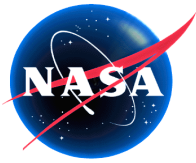
- Radiation circumvention is enabled for the 724 short wave channels in modules 1-4. Of these, the thresholds for modules 1-2 are set too low (signal is being clipped for very warm scenes).



ADF 752,  
M. Weiler

Full Scale (64) = 48516 Counts per Scan Line





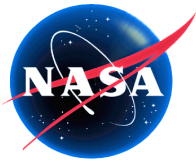
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# Summary



- 56 currently unusable channels (high noise/unstable due to a radiation hit or “dead”) can be made usable by changing weights.
- 94 can be improved substantially.
- 13 have anomalous gains on both detectors and are downgraded to not usable (i.e., “dead”)
- There is margin in the current circumvention threshold settings to allow for an increase, reducing clipping of signal in warm scenes for SW channels in modules 1 and 2.
- List of candidate channels follows



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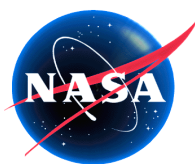
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# List of Candidate Channels (1)



PGE	freq	V5	206 C8	Con- sensus	Rad hit	Dead det	Strow goods	Strow bads	Comment/ Observation
277	728.7	4	2	2				1	B is better; last pre-anom C2s > 1 NEDT - recovered?
288	732.0	0	5	5	1			1	R; 2/5? B N3sig 282/107, B C2s ok, AB worse in 2010; A popped.
300	735.7	3	2	2	1			1	R
302	736.3	0	2	2	1			1	R
323	742.9	0	2	2				1	2; look at recent NeN; 0.8v0.4 NEDT; NeN plot looks ok pre-shutdown(also A+B v B only)
324	743.2	3	5	5				1	5; A 3sig + higher NEDT.
326	743.8	1	2	5	1			1	R; 5; A pops, B N3sig in 128; NEDT 1-2.4K in C2s.
329	744.7	0	1	1				1	1; B large N3sig 676/107, popped in 203; comp NEN 330
331	745.4	5	2	4				1	2/5 v 1/4; A pops, N3sig but < NEDT; 5->1/4 (A steady in C2s ->1)
341	748.6	0	1	1				1	1; A 2x better NEDT since 1/05
349	751.1	0	2	2	1			1	R
353	752.4	3	2	2				1	2; A pops a lot, B C2 clean. A+B NEN plot shows lots of pops.
384	762.5	0	2	2	1			1	R
386	763.2	1	2	2				1	B better after solar flare shutdown
387	763.5	0	1	1	1			1	R
392	765.2	0	1	1				1	B pops, NeN looks ok with little spikes
396	766.5	3	4	4				1	A better NEDT but pops, B N3sig 522/107
398	767.2	0	0	1				1	C; A+B has lots of noise flags, C2 B has recent large noise excursions
404	769.2	5	1	1		1		1	1/4; B dead; A N3sig 286 in 127. Looks ok in recent C2/C7/C8; not great relative to neighbors
411	771.6	0	2	2	1			1	R; NEN raggedy
415	772.9	4	4	5				1	B better. NEDT .9 v 1.7 NEDT in C2s but N3sig 369; A+B NEN plot ugly.
420	774.6	5	2	4				1	4; A better NEDT w N3sig 305/107; A C2s don't move much, .6-.8; B .8-1.2; B NEN plot ugly, lots of
437	780.5	0	1	1			1		1; B pops regularly; NEN plot spiky.
444	790.0	0	2	2	1			1	R
446	790.7	0	0	1	1			1	R - C2's indicate B hit.
453	793.2	0	2	2	1			1	R
463	796.8	5	4	4				1	4; both bad; A is better, B N3sig 565/107 and worse restart
476	801.5	0	1	1	1			1	R
480	802.9	0	2	2	1			1	R
481	803.3	0	2	2	1			1	R
487	805.5	3	4	5				1	5; B better since 5/09 but N3sig 290/107 and pops
489	806.2	4	5	5				1	5; A N3sig, C7/C8 different, B good until 6/04, a little better?, more likely to recover
510	814.0	0	0	1				1	H, V; noise flags
514	815.5	1	2	2				1	2; A C2s bad, B good for a long time
518	817.0	0	1	1				1	1; A is better, B pops, has some noise flags
526	820.1	3	1	1	1			1	R
531	822.0	4	5	5				1	5; A popped 202, worse since 10/05
534	823.1	0	5	5				1	5; 0 worse since restart. N3sig, no pops.

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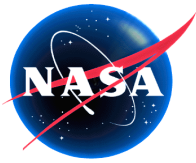
# List of Candidate Channels (2)



PGE	freq	V5	206_C8	Con-sensus	Rad hit	Dead det	Strow goods	Strow bads	Comment/ Observation
543	826.6	1	1	5				1	2; A 1K +CSN? v. B 0.5K + pops sporadically; A worse NEN after anomaly & noise "pops" in NEN c
548	828.5	3	1	1				1	Ok
551	829.7	0	2	2			1		2; B better noise, A popped 204, A+B noise +0.05K after restart
582	841.9	4	4	5				1	5; B better (but bad/pops)
583	842.3	5	5	4				1	4; A better (but N3sig 614/107!)
588	844.3	3	3	4				1	4; both pop, A low noise, pops much less (62v1) (both pop, pick better one)
591	845.5	5	1	1				1	Ok; A N3sig in 127
592	845.9	0	2	2			1		A N3sig 430/107; 2 a bit cleaner in C2 data
596	847.5	2	3	4				1	1?; B NEN ragged; both N3sig, A less so (not on 202); A better since 11/05
600	849.2	0	1	1	1		1		R
604	850.8	5	3	4				1	4/1; B pops (and huge N3sig); NEN plot of B not good. A N3sig 251.
621	855.2	0	0	2	1			1	R - A side hit 3/08 - NEN appears recovered (but a little spiky); 2 probably safer
636	859.9	0	3	5				1	5; B is better in C2s; N3sig only with circ on
647	863.3	0	0	1	1		1		R
655	865.8	0	1	1	1			1	R
670	870.6	1	2	2				1	2 safer?; A N3sig only 204. B better but in A for CSN? A cleaned up NEN after shutdown.
678	873.2	4	2	2				1	2; B is better unless CSN?. A N3sig thresh in 304. A NEN bad.
679	873.6	0	0	1	1			1	R
699	880.1	0	1	1	1		1		R -B improved after shutdown, but still bad ~1.5K
715	885.4	0	1	1	1		1		R
733	891.4	4	2	2				1	B much better, even if it has CSN
736	892.4	4	3	6		1		1	6; A & B irregular gains.
738	893.1	3	1	1	1			1	R
742	894.5	4	5	5		1		1	5; A dead
743	894.8	4	5	5		1		1	2/5: A dead; B N3sig 389/107
747	896.2	3	3	5		1		1	5; A dead
749	896.9	3	5	5		1		1	5; A dead
755	898.9	4	4	5		1		1	5; A dead, B N3sig 545/107
756	899.3	5	1	1		1		1	B dead
758	900.0	0	2	2	1			1	R
760	900.7	1	2	2				1	A N3sig; George says got worse
765	902.4	4	4	5		1		1	5; B popped, A dead
768	903.4	0	0	2				1	2; B better since 7/06
783	915.9	5	5	4		1		1	4; B dead, A huge pops
784	916.2	0	0	2				1	C - ok - which has CSN? 204(A) has irregular N4sig with circ on (not in 202); A had one high C2 (6
802	922.7	5	5	4				1	4;A pops, pop mag = 34; B noise = 84; 0.3 v 3.6 NEDT
812	926.4	0	0	2				1	P - B quieter
831	933.4	5	4	4				1	4; A N3sig 373/107
837	935.7	4	3	5		1		1	5. A is dead, abnormal gain.
842	937.5	4	5	5				1	5; both bad, A 10x better

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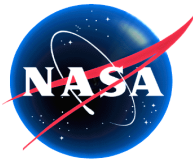
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# List of Candidate Channels (3)



PGE	freq	V5	206 C8	Con- sensus	Rad hit	Dead det	Strow goods	Strow bads	Comment/ Observation
850	940.6	0	2	2				1	C; A N3sig, pops
855	942.4	4	2	2				1	? 2, or 5 if has CSN
860	944.4	1	2	2				1	C; A popped; B more stable C2s
864	945.9	1	2	2				1	2; B seems 3x-4x better
865	946.3	4	4	5				1	5; A>1K; B N3sig356
867	947.0	3	3	5		1		1	5; A dead, abnormal gain
868	947.4	5	1	1				1	1, A slight N3sig on 127
875	950.1	3	3	5		1		1	A dead gain, B noisy
879	951.7	2	1	1				1	1; A 6x better, good according to C2s
884	953.6	4	4	2				1	2 or 5; B much better, N3sig thresh
894	957.5	3	3	5				1	5 better (but bad)
900	959.9	4	2	2				1	2 better
907	962.6	5	4	4		1		1	B dead.
911	964.2	0	5	5				1	B 2x better than A; A+B variable (see NEN), A relatively steady in C2s; 5 relative to neighbors
919	967.4	4	4	5				1	5 better noise but pops a lot
920	967.8	4	2	2				1	2 better; B N3sig 253 on 128
928	971.1	1	2	2				1	2; 5 if CSN
930	971.9	4	4	5				1	2/5; N3sig 315
941	975.4	1	2	2				1	R - ok; A N3sig, pop 202, NEN ragged since restart
947	977.9	4	4	6		1		1	6; Both bad gains.
952	980.0	5	1	1				1	1; N3sig 283 on 127
954	980.8	4	3	5				1	5 better
955	981.2	0	2	2				1	2; A N3/4sig
957	982.0	4	4	5		1		1	2/5 - A dead, BN3sig & pops
996	998.4	0	1	1	1			1	R
1037	1016.2	0	2	2	1			1	R
1039	1017.1	1	2	2				1	C - see NEN. A pop once in 204 (not 202).
1046	1020.2	1	5	5				1	A is H, go 2/5 - B N3sig 273, 406
1047	1020.6	0	1	1				1	B barely N3sig 220,239; NEN low but irreg; A C2s steady, B somewhat irregular
1066	1029.2	4	4	6		1		1	both dead
1092	1041.1	0	1	1				1	1; A better but ECMWF; NEN ratty (like mild CSN)
1096	1042.9	0	1	1	1			1	R (recovered? C2 good since 2/09), B N3sig(in 205 only). NEN ragged, but low.
1105	1056.6	4	5	5				1	5; A worse & pops, B N3sig 403,312
1109	1058.5	4	3	6		1		1	both dead
1112	1059.9	1	0	2				1	2. NEN spiky after shutdown, unless B CSN
1125	1066.2	4	3	5		1		1	5; A dead, B bad
1126	1066.6	2	2	1				1	C; confirmed real bad in NEN
1129	1068.1	1	0	2				1	2 better? unless B CSN. A NEN some spikes.
1132	1069.6	5	1	1	1			1	R

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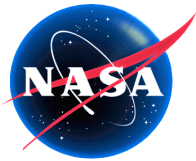
# List of Candidate Channels (4)



PGE	freq	V5	206_C8	Con-sensus	Rad hit	Dead det	Strow goods	Strow bads	Comment/ Observation
1134	1070.5	0	2	2				1	2. A N3sig 229, higher noise, NEN higher since restart.
1141	1074.0	0	0	2				1	huge number of noise flags
1142	1074.4	0	2	2			1		B better; ECMWF, A borderline N3sig, NEN variable
1148	1077.4	4	4	5				1	5 better
1173	1089.9	5	5	4				1	4 better? A N3sig, popped 202
1176	1091.4	0	0	1				1	P - NEN cleaner on restart, but probably safer to go with A
1180	1093.4	0	2	2	1			1	R - NEN better after restart, but safer to go B only.
1193	1100.1	3	5	5				1	5 better
1197	1102.1	1	0	2				1	2; unless B has CSN? A NEN is spiky.
1203	1105.2	4	4	5				1	5 better
1208	1107.8	4	4	5				1	5 better
1240	1124.7	5	3	6		1		1	both dead
1251	1130.7	4	2	2				1	A N3sig, pops; A C2s look bad. B better even if CSN.
1255	1132.8	4	4	5		1		1	5 - A dead or very bad.
1328	1250.8	2	2	1				1	C,P -trade NeDT for CSN improvement? Pop flag triggered as well.
1354	1264.9	1	4	5				1	5; B N3sig (589/107)
1355	1265.4	4	4	5				1	5; B Pops, N3sig
1380	1290.6	1	2	2				1	2 or 5; B 5x better; B N3sig 250 in 128
1453	1333.4	0	1	1	1			1	R; better since restart, but not good.
1515	1365.1	4	5	2				1	2 or 5; B improved in '04; B N3sig 226 in 128
1579	1399.9	0	1	1	1			1	R - NEN horribly spiky.
1690	1481.9	2	1	1				1	1; A 4x better, N3sig 509 in 127, ok now
1712	1495.8	1	2	2				1	2; B 4x better, N3sig in 128
1728	1506.0	5	4	4				1	4/1?; B dead; A N3sig 260
1731	1508.0	5	4	4				1	4; B dead
1750	1520.4	0	2	2	1		1		R; NEN somewhat better after restart.
1770	1547.2	0	0	1				1	1 to be safe; has Nflags; NEN cleaner on restart
1781	1554.7	4	4	6		1		1	6; both dead.
1783	1556.1	0	1	1				1	1; B bad in 4/05
1788	1559.6	4	3	6		1		1	6; both dead.
1802	1569.3	5	1	1	1			1	R
1809	1574.2	0	1	1	1			1	R
1817	1579.9	0	1	1	1			1	R; recovered? - 1/25 C2 ok; B slight N3sig; NEN lower but irregular, a few spikes
1828	1587.7	0	1	1	1			1	R; B N3sig 378/107
1829	1588.4	0	1	1				1	1; A better, B 9/10 pops 205/203; NEN a little ragged since restart
1841	1597.0	0	3	2				1	H,P; A popped, B N3sig
1842	1597.8	1	2	2	1			1	R; A hit in 6/08
1922	2234.3	4	4	6		1		1	6; both dead
2013	2324.0	5	4	6		1		1	6; both dead
2014	2325.1	5	3	6		1		1	6; both dead

Column headers described at end of table





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## List of Candidate Channels (5)



PGE	freq	V5	206_ C8	Con- sensus	Rad hit	Dead det	Strow goods	Strow bads	Comment/ Observation
2067	2347.8	0	1	1	1			1	R; quieter since restart, but spiky
2257	2566.4	5	5	6		1		1	Shadowing? A/B gain degrade equally.
2259	2568.6	5	5	6		1		1	Shadowing? A/B gain degrade equally.
2263	2543.9	5	5	6		1		1	Shadowing? A/B gain degrade equally.
2288	2569.3	0	1	1	1		1		R
2357	2642.2	3	1	1	1			1	R

PGE = PGE channel number

Freq = frequency

State: 0, 1, 2 = good A+B, A, B;

3, 4, 5 = use with caution A+B, A, B;

6 = unusable ("dead")

V5 = version 5 state

206\_C8 = optimal state based on special test 206

Consensus = consensus optimal state (by S. Broberg, M. Weiler)

Reasons for change:

Rad hit = radiation hit

Dead det = unusable detector (anomalous gains)

Strow goods/bads = L. Strow use/don't use channel lists